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more troublesome to the Marriners, and therefore the Tables last printed by Pitiscus were omitted as overtedious, his first being annexed herewith for the more ease in working. But if any man desire those Tables themselves, they may buy them apart in the Latin printed at Franckford, 1612.' In view of these observations it would seem that the tables of Pitiscus were not unknown in this country; and it appears unlikely that the mathematicians who used the decimal point in the English edition of the 'Descriptio' of 1616 were unacquainted with the tables of 1608 and 1612, in both of which it had been used."]

Tôhoku Mathematical Journal, volume 18, nos. 1 and 2, August, 1920: "Generalization of Bessel's and Gram's inequalities and the elliptic space of infinitely many dimensions" by K. Ogura, 1–22; "The irreducible cases of algebraic solutions" by C. E. White, 23–33; "Remarque sur un théorème relatif aux racines de l'équation $a_nx^n + a_{n-1}x^{n-1} + \ldots + a_1x + a_0 = 0$ où tous les coefficients a sont réels et positifs" by G. Eneström, 34–36; "Theorems on convergent integrals" by T. Kojima, 37–45; "A proof of a theorem of Haskell's" [in Japanese] by T. Kubota, 46–48; "On the interpolation by means of orthogonal sets" by K. Ogura, 49–60; "On the interpolation by Legendre polynomials" by K. Ogura, 61–74; "On certain inequalities" by T. Hayashi, 75–89; "Sur les courbes orbiformes. Leur utilisation en mécanique "by G. Tiercy, 90–115; "On the passing of simple continuous arcs through plane point sets" by J. R. Kline, 116–125; "Einige Sätze über charakteristische Eigenschaften gewisser Flächen" by T. Kubota, 126–127; "On Bertrand curves" by M. Tajima, 128–133; "On continuous set of points, II" by K. Yoneyama, 134–186; Shorter notices and reviews, Miscellaneous notes, 187–203.

Zeitschrift für mathematischen und naturwissenschaftlichen Unterricht, volume 51, nos. 7–8 (published July 22, 1920): "Fragen der Oberlehrerausbildung mit Beziehung auf angewandte Mathematik und Technik by R. Rothe, 177–190; "Die Genauigkeit des logarithmisch-trigonometrischen Rechnens" by A. Fischer, 191–195; "Die Einführung des Kraftbegriffes auf der Oberstufe" by K. Hahn, 195–198; "Bildliche Darstellungen gewisser Summenformeln" by K. Bochow, 198–203; [geometrical representations of $\sum_1^n n^2$, $\sum_1^n n^3$, and $\sum_1^n n^4$, together with their relations to each other and to $\sum_1^n n$;] "Zur Vielpassaufgabe" by H. Dostal, 204; "Aufgabenrepertorium," 204–207; [Discussion of the system of equations $ax + (a + n)y + (a + 2n) = 0$, $(a + 3n)x + (a + 4n)y + (a + 5n) = 0$] by P. Schulze, 216.

UNDERGRADUATE MATHEMATICS CLUBS.

SEND ALL REPORTS OF CLUB ACTIVITIES TO E. L. DODD, UNIVERSITY OF TEXAS, AUSTIN, TEXAS.

CLUB TOPICS.

18. Finite Geometries. By U. G. Mitchell, University of Kansas.

General analytic and synthetic definitions of finite (or modular) projective geometries were given by Veblen and Bussey, *Transactions of the American Mathematical Society,* Vol. 7 (1906), pp. 241–259. They used the symbol $PG(k, p^n)$; where k, p and n are integers and p a prime, to represent a finite projective space of k dimensions having $p^n + 1$ points on every line. As they pointed out (pp. 258–259) the finite geometries so defined included many new configurations[1] and many that were already well known. The $PG(k, p)$ had been defined synthetically by Fano[1] and analytically by Hessenberg[2] and its group properties had been studied by Moore.[3]

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[1] The term "configuration" in its projective geometry sense seems to be due to Theodor Reye who used it first in 1876 in his *Geometrie der Lage,* Band I, 2 Aufl., S. 4, and who defined the term for the two-space and three-space in his article "Das Problem der Configurationen" in *Acta Mathematica,* Vol. 1, pp. 93–96. The general matrix definition now in use was given by E. H. Moore, "Tactical Memoranda," *American Journal of Mathematics,* Vol. 18 (1896), pp. 264–303.

Veblen and Bussey (*l.c.*) developed a method for constructing all configurations which satisfy the definition and showed that they have a geometrical theory identical in most of its general theorems with ordinary projective geometry. They thus afford a treatment of finite linear group theory analogous to the ordinary theory of collineations.

Some of the geometric properties of the $PG(2, 2^n)$ have been given by the writer[4] and the three-space $PG(3, 2)$ was studied by Conwell.[5] Conwell showed that the group theory of the $PG(3, 2)$ furnishes a complete solution to Kirkman's school-girls problem[6] and is related to several functions which are of importance in the Galois theory of equations. Veblen[7] made use of finite geometries in considering the problem of map-coloring and H. H. Mitchell[8] determined the finite ternary and quaternary linear groups (previously determined by other methods) by geometrical methods suggested by finite geometries.

A systematic treatise (159 pp.) on trigonometry, logarithmic curves and the geometry of the straight line, circle and conics in a modular space of two dimensions was published in 1911 (Paris, Gauthier-Villars) by Gabriel Arnoux[9] under the title *Essai de Gêomêtrie analytique modulaire a deux Dimensions.*

Dickson, in the *Madison Colloquium Lectures* (Amer. Math. Soc., 1914), discussed modular geometry and covariantive theory of a quadratic form in m variables, modulo 2 (Lecture IV), and a theory of plane cubic curves with a real inflexion point valid in ordinary and in modular geometry (Lecture V).

Much of the theory developed in Veblen and Young's *Projective Geometry,* (Boston, 1910 and 1918) is as valid in modular as in ordinary projective geometry.

A brief discussion of the $PG(2, 3)$ was given by Bennett in this MONTHLY for October 1920, pp. 357–360. His remarks on the significance of modular geometry (pp. 360–1 and footnote) should also be noted in this connection.

Finite geometries are useful in illustrating clearly the relation between euclidean and projective geometry. For example, if the finite euclidean plane geometry, modulo 3, be pictured it will be seen to consist of 9 points and 12 lines and that the addition of the 4 ideal points in which these lines meet and the addition of the ideal line on which the 4 ideal points lie gives the finite plane projective geometry, modulo 3, consisting of 13 points and 13 lines.

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[1] "Sui postulati fondamentali della geometria projettiva," *Giornale di Matematiche,* Vol. 30 (1892), p. 106.

[2] "Ueber die projective Geometrie," *Sitzungsberichte d. Berl. math. Gesellschaft,* 1902–03, pp. 36–40.

[3] "Concerning Jordan's linear groups," *Bulletin Amer. Math. Society,* Vol. 2 (1895–96), pp. 33–43.

[4] "Geometry and Collineation Groups of the Finite Projective Plane $PG(2, 2^2)$," Lawrence, Kansas, 1913.

[5] "The Three-Space $PG(3, 2)$ and its Group," *Annals of Mathematics,* Vol. 11 (1910), pp. 60–76.

[6] For history of this problem and bibliography of literature relating to it, see Ball's *Mathematical Recreation and Essays,* fifth ed. (London, 1911), pp. 193–223.

[7] *Annals of Mathematics,* Vol. 14 (1912), pp. 86–94.

[8] *Transactions of the American Mathematical Society,* Vol. 12 (1911), pp. 207–242, and Vol. 14 (1913), pp. 123–142.

[9] The first sentence of the preface, however, gives credit to collaborators in the following language:

"Bien que le présent Livre sur la couverture mon nom seul, il a été en réalité le résultat d'une véritable collaboration entre M. Laisant, M. Gaston Tarry et moi."

In working with modular geometries recently the writer observed that if the point $(x_n, x_{n-1}, \cdots, x_1)$ in the euclidean geometry $EG(n, p)$, be taken to represent the integer $x_n p^n + x_{n-1} p^{n-1} + \cdots + x_1$, where p is any prime and $x_1, x_2, \cdots x_n$ are marks of the Galois Field $GF(p)$, we have a geometric representation of the positive integral number system from 0 to p^{n+1}. The algebra of points in the $EG(n, p)$ would then be abstractly identical with the arithmetic of the corresponding integers and should afford a geometric attack on problems in number theory (*e.g.*, the problem of primes). In the correspondence thus set up the coordinates of a point become the ordinary positional notation for its corresponding number when the number is expressed in a scale whose radix is p. For example, if $p = 3$ the point (1, 2, 2) in the euclidean three-space $EG(3, 3)$ is the number 122 in the ternary scale or 17 in the decimal scale. Since the number of primes is infinite and such a correspondence can be set up for every prime we thus have an infinite variety of ways of representing the positive integral number system geometrically. Obviously other ordered correspondences can be set up for fields formed by adjoining other units. Hence it seems not unlikely that finite geometries may find important applications in the theory of equations, as, perhaps, might have been expected from the fact that they have found immediate applications in group theory.

CLUB ACTIVITIES.

The Mathematics Club of Brown University, Providence, R. I.

[*1918*, 33; *1919*, 167; *1920*, 28, 223.]

The officers of the club for the year 1920–21 are:

Chairman, Professor Roland G. D. Richardson.

Committee on Program, Professor Raymond C. Archibald, Professor Robert W. Burgess, Rachel T. Easterbrooks Gr., Elsie E. Lord '21, Clarence M. Eddy '22, Everett L. Sweet '21.

Committee on Arrangements, Raymond L. Wilder, Assistant in mathematics, Katherine E. Colton '22, Margaret C. Packer '21, Allan A. Edgcomb '22, Francis L. Jones '23, Kenneth H. N. Newton '22.

Programs for the current year follow.

October 29, 1920: "Interpolation" by Albert A. Bennett '10, Associate professor of mathematics, University of Texas.

December 10: "Curiosities in numbers" by Margaret C. Packer '21; "Construction and use of mortality tables" by Philip M. Brown '22; "Stephen Leacock as biographer and epistemologist"[1] by Nellie C. Stokes '23.

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[1] S. Leacock, "A, B, and C, the human element in mathematics" and "Boarding-house geometry" in *Literary Lapses*, London, 1912.

January 14, 1921: "Geometrical dissection of figures" by James B. Hobbs '18; "The problem of squaring the circle" by May B. Carter Gr.

February 18: "A new conograph" by Allen A. Edgcomb '22; "Incidents in the lives of mathematicians" by Constance W. Haley '21, Charles Hopkins '22, Elsie E. Lord '21, Edward S. Skillings '23, Helen F. Sheehan '22, Everett L. Sweet '21.

March 11: "Geometrical conics" by Julian L. Coolidge, Professor of mathematics, Harvard University. The club picture is to be taken at this meeting.

April 15: "Sir Isaac Newton" by Stuart H. Tucker '22; "The origin of our numerals" by Rose M. Finkelstein '22; "Gear ratios" by Kenneth H. N. Newton '22.

May (date to be announced later): Picnic.

THE MATHEMATICS CLUB OF THE UNIVERSITY OF KANSAS, Lawrence, Kansas. [*1918*, 35, 450, 459; *1919*, 208; *1920*, 76.]

The officers of the club for the year 1920–21 are as follows: President, Nadene Weibel '21; vice-president, Vera Steininger '21; Secretary-treasurer, Lillie Strand '21; reporter, Sidonie Schafer '21; faculty adviser, Professor Ulysses G. Mitchell; program committee, Marie Shaklee '21, Marie McKinney '21, the secretary and the faculty adviser.

Programs for the year 1920–21 are given below.

October 13, 1920: "In times of rhymes," a review of an old textbook, by Professor Ulysses G. Mitchell.

October 27: "How elementary mathematics is used in astronomy" by Dinsmore Alter, Associate Professor of Astronomy, University of Kansas.

November 10: "Some peculiar graphs," by Assistant Professor Guy W. Smith.

December 8: "How elementary mathematics is used in chemistry" by Ralph Buffington Gr.

January 5, 1921: Review of Dudeny's "*Canterbury Puzzles*" by Vera Steininger '21.

January 19: "Some inherited problems" by Fern Smith Gr.

February 9: "The fourth dimension" by Lillie Strand '21.

February 23: "Card tricks" by Nadene Weibel '21.

March 9: "The great cryptogram,"[1] the argument for Bacon's authorship of Shakespeare's works, by Gladys Jones Gr.

March 23: "The arithmetic teaching of a hundred years ago" by Marie Brown '21.

April 13: "Reliability of teachers' marks" by Nina McLatchey, Instructor in mathematics.

April 27: "Arithmetical prodigies" by Ruth Strickler Gr.

May 11: "The story of Hypatia" by Jessamine Fugate '22.

May 25: Annual Picnic.

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[1] Cf. Ignatius Donnelly's book *The Great Cryptogram*, R. S. Peale & Co., Chicago, N. Y., London, 1888.